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COMPARISON OF THREE DIFFERENT OT TABLE HEIGHT FOR INTUBATION IN TRAINEES— AN ERGONOMICS VIEW

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ABSTRACT

Background: Specific postures and practitioner ergonomics are not universally defined within intubation training. No particular landmark is there that indicate at what level patient's head should be during intubation. The aim was to evaluate the effect of different OT table height on intubation time, success rate, and laryngeal view grading and posture discomfort. We decided to understand physical ergonomics of successful laryngoscopy posture and to improve trainees' learning curve.

Methods: Seventy five patients divided into three groups according to patient's forehead at the level of intubator's nipple line (group N), xiphisternum (group X) and umbilicus (group U). An observation for intubation time, success rate, discomfort in ventilation & intubation and posture was made. From left sided photographs- neck & knee flexion angle, distance from intubator's eye to heel of scope (cm) was noted.

Results: Table height at nipple level makes intubation less time consuming (p= 0.001) and with ergonomically erect posture and better laryngeal view. Distance from trainee's eyes to heel of scope was more in group N (p value < 0.001). Trainees tended to crouch towards patient's mouth with bended posture in group U and group X than group N.

Conclusion: Higher OT table height can provide much better laryngeal view in erect posture with less discomfort and less time consuming intubation. Trainees must be taught and prefer to set OT table height at nipple level making them erect and comfortable in posture.

KEYWORDS: Intubation, OT table height, Ergonomics, Posture.

INTRODUCTION:

Acquiring a new skill requires learning of correct posture e.g. Piano teachers first teach how to sit and skiing instructors are equally firm on how we should stand?[1] In cricket, each perfect shot require particular posture as well as action. Surgeon insists to have OT table height closer to their hands, head and neck surgeon keeps their eyes on patient positioning before starting procedure. Then how do we stand behind in teaching the correct posture during laryngoscopy? As an anaesthetist, we must insist for perfect patient position and OT table height for intubation. Because of the inherently chaotic environment of induction situations, personnel proficiency in performing intubation procedures can range widely. There are many studies related to instruments or methods explored to find success in intubation whereas there are few studies for OT table height or posture in laryngoscopy in relation to success.[2] Standard textbooks of anaesthesiology stated that the patient's face should be at a level between the xiphisternum and umbilicus of the anaesthetist during laryngoscopy.[3] And that the intubator's eyes should be placed at one feet above patient's face to provide proper angles and distances for laryngoscopy.[4] We noticed wide variation in adoption of this guidance. Anaesthetists with average height do not have much problem but with height more than 170 cm, more compensation has to be made with lower body posture during intubation. We decided to evaluate the effect of three different OT table heights on duration and success rate of intubation, posture adopted and perception of difficulty to intubator[3].

Ergonomics refers to designing of equipment, machines and systems to accommodate behaviours, characteristics and expectations of human beings who use them in everyday working and living environment. Awkward postures during daily anaesthesia work such as intubation, vascular access, neuraxial anaesthesia etc., these ergonomic risks are known for developing spinal diseases such as herniated discs and lumbar muscle contractions. Heath highlighted the benefits of using an adjustable operating table and the ergonomically attractive benefits of different heights- high during cannulation to prevent back discomfort, a bit lower for airway management and even lower for short trainees.[3]

Aim of our study is to evaluate the effect of three different OT table height on duration and success rate of intubation, posture adopted, perception of difficulty to intubator.

MATERIALS AND METHODS:

The study was approved by institutional ethical review committee. 25 trainees (residents having experience of more than 7 months, 14 males and 11 females) as performer and 75 patients of Age between 18--60 year and ASA grade I and II posted for elective surgery under general anaesthesia were included in the study. The following patients were excluded from the study: ASA III and IV patients, Obese (BMI >30), patients of obvious difficult intubation such as patients with MPG III and IV, previous oral or neck surgery, thyromental distance less than 6.5 cm, loose teeth or edentulous jaws and patients at risk of aspiration. Airway assessment was done day before surgery for each patient.

Patients were grouped randomly in three groups (25 patients in each) on the basis of OT table height as pt.'s forehead at level of intubator's body landmarks as 1) Group N: level of Nipples, 2) Group X: level of Xiphisternum, 3) Group U: level of Umbilicus. Each performer received a brief overview of airway anatomy, standard terms of intubation procedures and each performer do one laryngoscopy in each patient.

All patients were fasted for 10 hrs. They were placed supine without keeping pillow. Routine monitoring such as non-invasive blood pressure, SpO_2, ECG were used. After Preoxygenation for 5 min, anaesthesia was given as Inj. Glycopyrrolate 0.02 mg, Inj. Fentanyl 2ug/kg, Inj. Thiopentone 6 mg/kg and Inj. Succinylcholine 2 mg/kg. Intubation was performed with Macintosh no. 4 blade with appropriate sized ET tube. During mask ventilation, perception of discomfort to ventilate was noted. During intubation, trainee inserted the blade into patient's mouth and evaluated the grade of laryngeal view using Cormack Lehane Grade. After completion of induction, subjective assessment of difficulty or discomfort in insertion of blade (1-no discomfort, 2-mild discomfort, 3-moderate discomfort, 4-severe discomfort), Cormack Lehane grade, success rate, average time of intubation were noted in each group. More than 2 intubation trial was considered as failure. Photographs, at the time of intubation, were taken 2 meters away from left side with 13 MP mobile camera. From left sided photographs, degree of arm elevation and neck/lower back/knee flexion during tracheal intubation were measured by using angle measurement mobile application named 'Protractor'. Upper body spine movement angle was measured between lines drawn from upper body spine and T_{12} vertebrae at umbilical level of operator.

Angle between line of sight and horizontal (A), angle between handle of scope and horizontal (B), angle between line of sight and handle of laryngoscope(C) were noted in each group. Distance from eye of performer to heel of laryngoscope (D) was measured. (Figure-1)

Statically analysis: Continuous variables are expressed as mean (standard deviation) whereas categorical variables are expressed as absolute values. Variables were compared using T test via www.graphpad.com. A p-value of <0.05 was statistically significant.

RESULTS:

25 trainees and 75 patients took part in the study. Two of our trainee having height 185cm and 182cm could not be included to do laryngoscopy in group N.

Demographic data of trainees are being comparable in both groups.

Tracheal intubations were successful in first attempt in group N and X but second attempt was taken for five patients (20% patients) in group U. Quality of laryngeal view as per Cormack Lehane grade was better in group N than at lower OT table heights. (Figure 1)

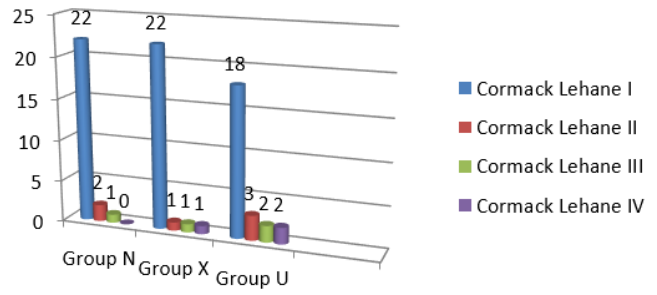

Figure 1: Quality of laryngeal view in each group

Graph showing better laryngeal view at higher OT table height in group N and X

Moderate to severe discomfort in insertion of laryngoscope blade (6 patients out of 25 patients, 25%) and severe discomfort in mask ventilation (2 patients out of 25) were higher in group N (Table 1). Five patients in group N needed toe tipping for insertion of laryngoscope blade into mouth. Narrower upper spine flexion angle was noted in group U and X due to forward body bending.

Intubation time was significantly less in group N (8.06±2.1 sec) than in group X and U ($p<0.001$) (Table-1).

During intubation, discomfort score was higher in lower OT table height (32% and 16% patients in group U and X respectively) than at higher position (Table-1).

During intubation, less neck forward bending as indicated by higher neck flexion angle was significantly higher in group N than in other groups ($p=0.001$) (Table-2).

The degree of knee flexion was higher at lower height (Group U) than at higher height ($p<0.0001$) (Table-1).

Distance from eye of performer to heel of laryngoscope, that was significantly more in group N (27.7±4.84 cm) ($p=0.001$) (Table-2 indicates that trainees tended to crouch on table with their face closer to patient's mouth during intubation in group U and group X.

DISCUSSION:

Specific postures and practitioner ergonomics are not universally defined within intubation training, and instruction typically follows the model of "see one, do one, teach one" within a variety of medical fields.[2] A trainee in anaesthesia must learn proper body posture and OT table height setup for decreasing ergonomic risks and improving intubation skills.

More erect posture was taken during intubation at operating table height at nipple level of intubator with less forward movement of upper spine and less knee flexion. Landmarks mentioned above were used because these are easily matched to operating table heights in routine practice. Why every trainee bend during intubation?? is really a question. It might be due to less confidence in intubation because trained anaesthetists only take crouched posture when they face difficult intubation. Two of our male trainees (Height 185 cm and 182 cm) had severe discomfort performing intubation in group U even after having knees flexed.

J D Walker[1] observed postures used by expert and trainee anaesthetist during intubation on mannequin. Results of their study show that less experienced group had shallower line of sight, levered more and stood with their face closer to the mannequin. The difference in angle A between the two studies may be because of our trainees levered laryngoscope more than lifting it. Novices always feel pressurised about success of intubation without teeth injury. These studies have used mannequin as subjects whereas we have done study on live patients. As, mannequins are not same as real subjects, less compliant and are difficult to intubate because of stiffness.

Adam de Lavega[2] et al studied ergonomics of novices and experts during simulated tracheal intubation at maximum and minimum height of adjustable bed. Observation was made that expert anaesthetist exhibited less ulnar deviation and forearm supination during task requiring less wrist manipulation. Identifying best practices in intubation biomechanics could shorten the learning curve, improve ETI success rates and reduce ventilation time in both emergent and controlled intubation situations. We also emphasize on learning improved techniques for mask ventilation and tracheal intubation by teaching trainees to set OT table height at higher level.

A Jayakumar[3] et al observed minimal effect on the speed ($p = 0.046$) but not success rate ($p= 0.14$) and significant effect of higher trolley height on perception of difficulty when performing intubation on manikins. Anaesthetists tend to adopt poor posture when trolley height is lower. Intubation duration is significantly higher in lower than higher OT table height (P 0.001). Our study also signifies early intubation, higher success rate, better posture and less perception of difficulty in intubation at higher trolley height than lower height. Poor posture in the form of knee and lower back flexion noted in group U and X especially by taller anaesthetists.

H.C. Lee[4] observed that the laryngeal view before postural changes was better at nipple level than in umbilicus level ($P=0.003$). The objective and subjective measurements of neck or lower back flexion during intubation were higher in Group U than in Groups X and N ($P=0.01$ for each). Higher operating tables (at the xiphoid process and nipple level of the anaesthetist) can provide better laryngeal views with less discomfort during tracheal intubation. Our study also shows higher degree of neck and lower back flexion angle in group U and improved laryngeal view at higher height (Group N). More flexion at knee level as well as upper spine movement angles were narrower in group U and X. From ergonomic point of view, body posture was very bad. This type of body posture was actually adjusted for laryngeal view to compensate for lower height of OT table.

According to the principle of ergonomics (the science of human factors), workplace design should be based on minimizing discomfort and maximizing performance because human reserves can compensate for poor layout without decrease of performance. So, it is important to place the operating table higher to minimize discomfort and maximize performance during tracheal intubation.

A. J. Matthews [5] et al observed the less experienced group compensate with upper body by stooping and bringing their face closer to patients reducing binocular vision. In our study data, angle A and angle D which indicates neck flexion and upper back flexion is more in group U than in group N. Lower OT table height make novices to lean forward with upper body parts as well as knee flexion in our study. Our study observed minimal bent or more erect ergonomic posture at OT table height at trainee's nipple level. Lower OT table height causes arm elevation which cause difficulty to lift anterior wall of trachea.

Laryngoscopy by macintosh blade requires abduction and rotation of upper arm. Combination of crouched flexed posture by trainee makes laryngoscopy more difficult and makes them closer to patient's mouth.

Two tall trainees (>182 cm) couldn't intubate in group U and they were not comfortable in group U. Short trainees (<137 cm) were most comfortable in group N than in group U. Overall, we noticed the intubation success rate depends on OT table height. So, OT table height at intubator's nipple level provided more erect and ergonomic body posture and lesser the musculoskeletal injury on long term and less stress for intubation success during induction phase.

We now teach trainees explicitly to try to stand straight and make distance from patient's mouth while attempting intubation. It is needed only to look in the mouth and not get into it.

CONCLUSION:

Higher OT table height can provide much better laryngeal view with less discomfort and less time consuming intubation. Trainees must be taught and prefer to set OT table height at higher level from day one. Intubation must be done with straight back and compensation for height should be made by knee joint flexion rather than stooping.

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Table 1: Laryngeal view, mask ventilation discomfort, discomfort in insertion of blade, intubation duration and number of attempts.			
Groups	**Group N**	**Group X**	**Group U**
Laryngeal view – Cormack Lehane (i/ii/iii/iv)	22/2/1/0	22/1/1/1	18/3/2/2
Mask ventilation discomfort (1/2/3/4)	20/2/1/2	13/12/0/0	22/1/2/0
Discomfort in insertion of blade (1/2/3/4)	5/8/6/6	24/1/0/0	25/1/0/0
Intubation discomfort (1/2/3/4)	24/1/0/0	19/2/2/2	14/3/3/5
Intubation duration (sec)	8.06±2.1*	9.7±2.02#	12.03±3.92$
Number of attempts (1/2)	25/0	25/0	20/5

Categorical variables are presented as the number of subjects whereas continuous variables are presented as mean(SD) *P <0.05 vs group U, #P <0.05 vs group U, $P <0.05 vs group N (Discomfort grades 1: No discomfort, 2: mild discomfort, 3: moderate discomfort, 4: severe discomfort)

Table 2: Different posture angles during Intubation				
Parameter	**Group N**	**Group X**	**Group U**	**p- value**
A	27.4±4.6	26.9±7.2	32.4±6.9	0.004*
B	99.62±3.27	110.6±10.9	105.24±11.09	0.02*
C	30.85±1.76	33.7±5.79	31.3±3.64	0.5
D	27.7±4.84	12.2±3.40	14.5±5.45	0.001*
Neck flexion angle	56.7±12.9	25.4±15.7	28.0±10.5	0.0001*
Upper spine movement angle	94.4±5.3	75.9±10.2	70.4±12.4	0.0001*
Arm elevation angle	36.4±3.9	35.4±3.6	32.3±5.9	0.005*
Knee flexion angle	15.6±2.5	45.5±11.4	70.3±10.4	0.0001*

(A: Angle between line of sight and horizontal, B: angle between handle of scope and horizontal, C: angle between line of sight and handle of laryngoscope, D: distance from eye of performer to heel of laryngoscope as shown in Figure-1) *p value (between group N and U) <0.05 statistically significant